Summary - Did performance of ST12 SEE System meet criteria for shutdown and transition?

Performance Criterion	Status as of termination of steam injection	Status as of termination of extracton System	Performance criteria met?
Mass removal rate less than 10% of peak recovery rate	Vapor recovery alone was 16% of peak recovery rate	Vapor recovery alone was 25% of peak recovery rate	no
Residual Benzene concentrations between 100-500 ppb to meet 20 year timeframe for EBR to be effective	Upper Water Bearing Zone and Cobble zone concentrations greater than 2000 ppb	NAPL still being recovered – concern that LNAPL and dissolved BTEX plume will spread if not contained	no
Steam injection 320 million lbs – equivalent to 1.6 pore volumes	302.4 lbs injected, 94% of goal	(no additional steam injection)	No – 1.6 pore volume was a minimum criteria, at least 2 pore volume flushing is ideal
Criterion for Pressure Cycling : *"the process is repeated . . .until no additional significant increases in effluent vapor concentrations occur when steam pressure is reduced"*	*Concentrations of benzene recovered in air stripper effluent were declining but still above 1000 ppb indicating significant recovery still taking place. Each pressure cycle was still producing significant increases in mass removal rates*		No
Steam temperatures reached uniformly in subsurface	We agree this criterion was met.		

Discussion on following pages

Status of performance criteria for shutdown of ST12 SEE system

a) As of date of shutdown of steam injection 3/9/16
b) As of date of shutdown of extraction system 4/29/16

1) Mass removal rate must be less than 10 % of the total peak recovery rate

a) *Vapor recovery alone* at the time of termination of steam injection was 16% of peak mass removal
b) Vapor recovery alone greater than 3000 lbs /day at time of termination of extraction system, 25% of peak recovery rate.

Performance Criterion for mass recovery or "diminishing effectiveness of SEE " was not met.

2) Residual benzene concentrations between 100 – 500 ug/l. As stated in RD/RA workplan, " this concentration range is predicted to achieve RAOS with the 20 year remedial timeframe...."

a) Although Lower saturated zone is achieving the objective as of shutdown of steam injection, Upper Water Bearing Zone and Cobble Zone still have LNAPL present in jar tests and benzene concentrations greater than 2000 ppb within the interior of the thermal treatment area.
b) Still considerable mobile LNAPL remaining in Cobble Zone interior of the thermal treatment area at the time the extraction system was shut down. There is considerable concern that LNAPL and dissolved BTEX will spread once the water levels recover and there is no hydraulic containment. Benzene concentrations still well over 1000 ppb.

Performance Criterion for residual benzene concentrations has not been met

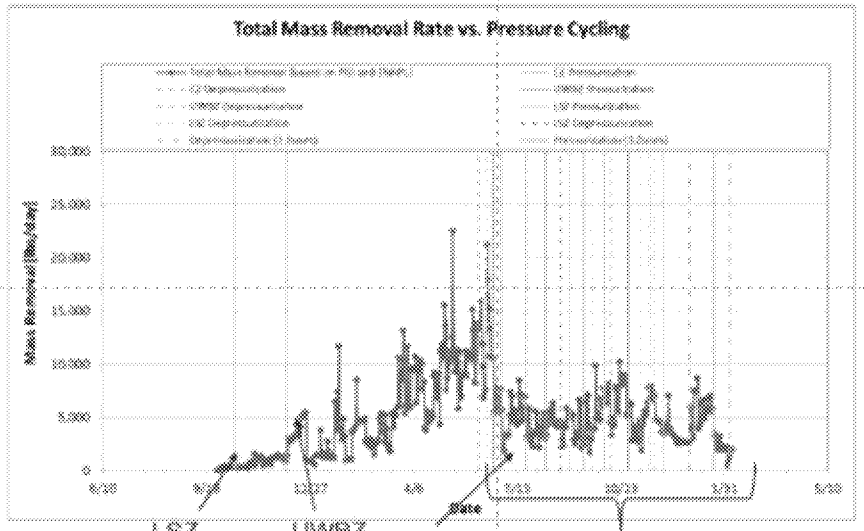
3) Criterion for Steam injection 320 million lbs of steam estimated to be required, equivalent to 1.6 pore volumes.

1.6 pore volume is relatively low for successful SEE project, at least 2 pore volumes is a more typical estimate for steam project. The SEE system was terminated after 302.4 million pounds of steam were injected, 94 % of what was originally estimated.

4) **Criterion for Pressure Cycling : *"the process is repeated . . .until no additional significant increases in effluent vapor phase concentrations occur when steam pressure is reduced" has not been met, as the figures below indicate that each pressure cycle was still producing significant increases in mass removal. The effectiveness had not diminished.***

Pressure Cycling & Mass Removal Over Time

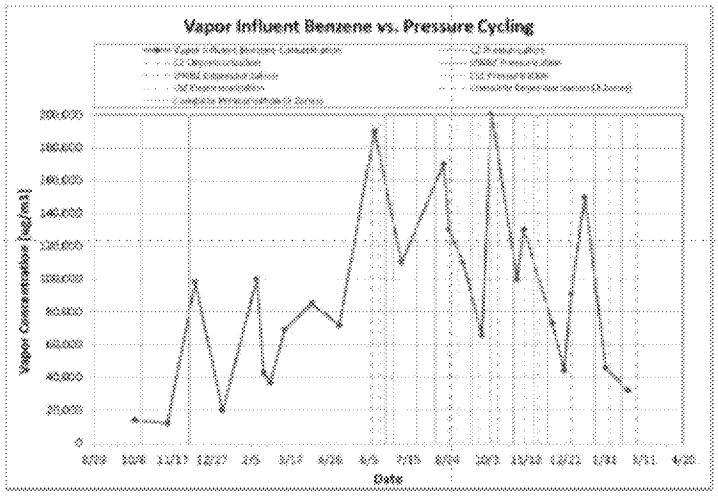
Mass Removal over Time



- Peak mass removal occurred April – June 2015 (vapor and NAPL phases)

Pressure Cycling & Benzene Vapor Mass Removal over time

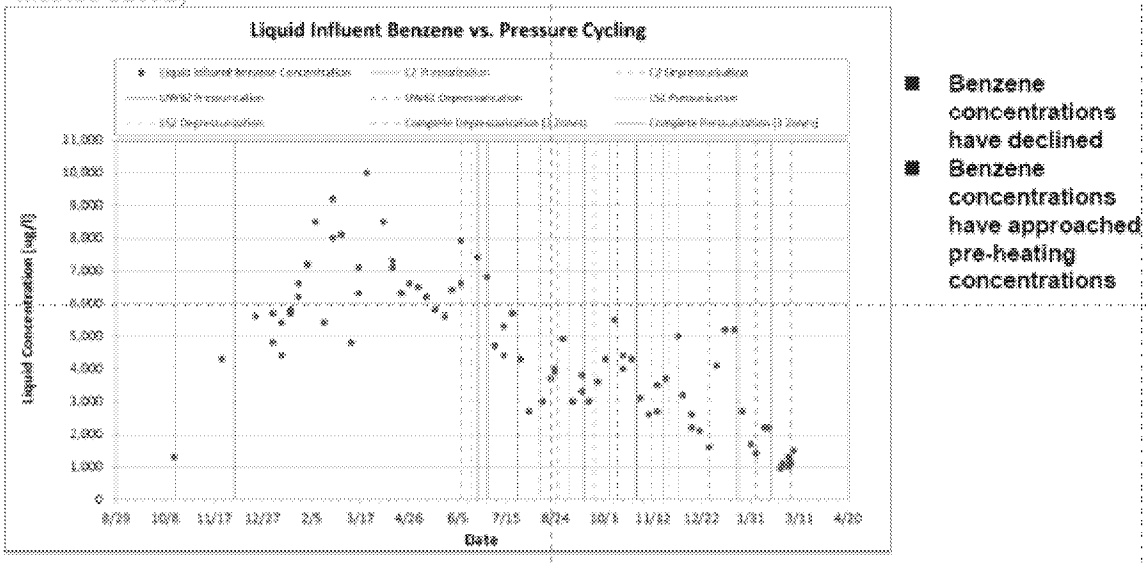
Extracted Vapor Benzene Concentrations over Time
(measured at thermal accelerator influent [includes air stripper effluent] by EPA Method TO-15)



- Benzene concentrations have fluctuated during pressure cycling

Pressure Cycling & Benzene Liquid Mass Removal

Extracted Liquid Benzene Concentrations over Time (measured at air stripper influent by EPA Method 8260B)



Concentrations of benzene recovered in air stripper effluent were declining but still above 1000 ppb indicating significant recovery still taking place.

5) Subsurface reaches boiling temperatures – we agree this criterion was met.